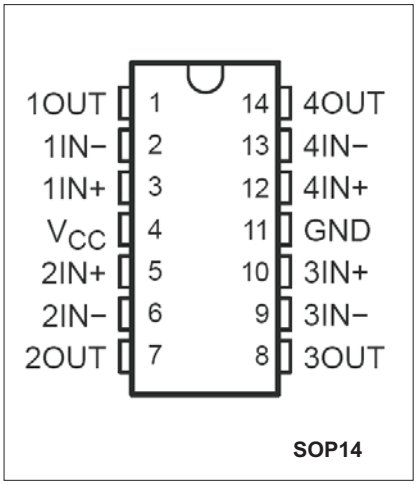
Quadruple Operational Amplifiers

LM324

■ Features

- 2-kV ESD Protection (K-Suffix Devices)
- Wide Supply Range:
  - Single Supply . . . 3 V to 32 V
  -or Dual Supplies . . ±1.5 V to ±16 V
- Low Supply-Current Drain Independent of Supply Voltage . . . 0.8 mA Typ
- Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground
- Low Input Bias and Offset Parameters:
  - Input Offset Voltage . . . 3 mV Typ
    A Versions . . . 2 mV Typ
  - Input Offset Current . . . 2 nA Typ
  - Input Bias Current . . . 20 nA Typ
    A Versions . . . 15 nA Typ
- Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage . . . 32 V
- Open-Loop Differential Voltage Amplification . . . 100 V/mV Typ
- Internal Frequency Compensatio



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■absolute maximum ratings over operating free-air temperature range

Parameter	Rating	Unit
Supply voltage, V_{CC} *1	±16 or 32	V
Differential input voltage, V_{ID} *2	±32	V
Input voltage, V_I (either input)	-0.3 to 32	V
Duration of output short circuit (one amplifier) to ground at (or below) T_A = 25℃,V_{CC} ≤ 15 V *3	Unlimited	
Package thermal impedance, θ_{JA}*4	76	℃/W
Operating virtual junction temperature, T_J	150	℃
Storage temperature range, Tstg	-65 to 150	℃
Charged-Device Model	±2	kV

*1 All voltage values (except differential voltages and V_{CC} specified for the measurement of I_{OS}) are with respect to the network GND.

*2 Differential voltages are at IN+, with respect to IN-.

*3 Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.

*4 Maximum power dissipation is a function of $T_{J(max)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_{J(max)}-T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150℃ can affect reliability.

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■ electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

Parameter	Symbol	T_A *2	Testconditons *1	Min	Typ *3	Max	Unit
Input offset voltage	V_{IO}	25℃	V_{CC} = 5 V to MAX,		3	7	mV
		Full range	V_{IC} = V_{ICRmin}, V_O = 1.4 V			9	
Input offset current	I_{IO}	25℃	V_O = 1.4 V		2	50	nA
		Full range				150	
Input bias current	I_{IB}	25℃	V_O = 1.4 V		-20	-250	nA
		Full range				-500	
Common-mode input voltage range	V_{ICR}	25℃	V_{CC} = 5 V to MAX	0 to V_{CC}-1.5			V
		Full range		0 to V_{CC}-2			V
High-level output voltage	V_{OH}	25℃	R_L = 2 KΩ	V_{CC}-1.5			V
		25℃	R_L = 10 KΩ				
		Full range	V_{CC} = MAX, R_L = 2 kΩ	26			
		Full range	V_{CC} = MAX, R_L ⩾ 10 kΩ	27	28		
Low-level output voltage	V_{OL}	Full range	R_L ⩽ 10 kΩ		5	20	mV
Large-signal differential voltage amplification	A_{VD}	25℃	V_{CC} = 15 V, V_O = 1 V to 11 V,R_L ⩾ 2 kΩ	25	100		V/mV
		Full range		15			
Common-mode rejection ratio	C_{MRR}	25℃	V_{IC} = V_{ICRmin}	65	80		dB
Supply-voltage rejection ratio (△V_{CC}/△V_{IO})	k_{SVR}	25℃		65	100		dB
Crosstalk attenuation	V_{O1}/V_{O2}	25℃	f = 1 kHz to 20 kHz		120		dB
Output current	I_O	25℃	Source V_{CC} = 15 V,V_{ID} = 1 V,V_O = 0	-20	-30	-60	mA
		Full range		-10			
		25℃	Sink V_{CC} = 15 V,V_{ID} =-1 V,V_O = 15 V	10	20		
		Full range		5			
		25℃	V_{ID} = -1 V, V_O = 200 mV	12	30		μA
Short-circuit output current	I_{OS}	25℃	V_{CC} at 5 V,GND at -5 V,V_O = 0,		±40	60	mA
Supply current (four amplifiers)	I_{CC}	Full range	V_O = 2.5 V, No load		0.7	1.2	mA
		Full range	V_{CC} = MAX,V_O = 0.5 V_{CC}, No load		1.4	3	

*1 All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.

*2 for 2 0℃ to 70℃

*3 All typical values are at T_A = 25℃.

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■operating conditions, V_{CC}=±15 V, T_A=25℃

Parameter	Symbol	Testconditons	Typ	Unit
Slew rate at unity gain	S_R	R_L = 1 MΩ, C_L = 30 pF, V_I = ±10 V (see Figure 1)	0.5	V/μs
Unity-gain bandwidth	B_1	R_L = 1 MΩ, CL = 20 pF (see Figure 1)	1.2	MHz
Equivalent input noise voltage	V_n	R_S = 100Ω, V_I = 0 V, f = 1 kHz (see Figure 2)	35	$nV/\sqrt{Hz}$

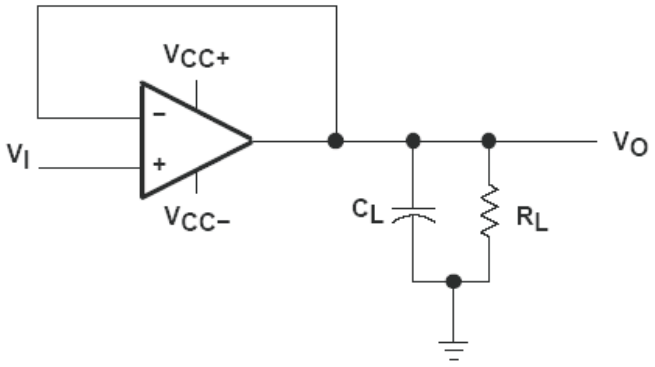

Figure 1. Unity-Gain Amplifier

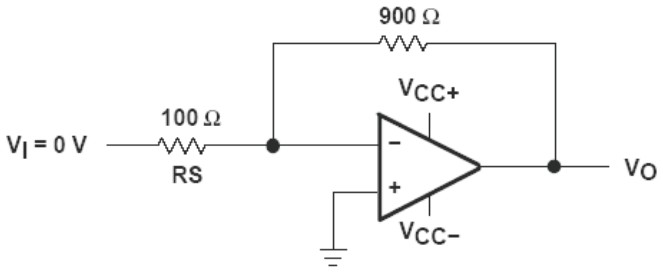

Figure 2. Noise-Test Circuit